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A SCIENTIFIC AND POLICY REVIEW

OF THE

DRAFT ENVIRONMENTAL IMPACT STATEMENT

ON THE

DEVELOPMENT OF COAL RESOURCES

IN THE

EASTERN POWDER RIVER COAL BASIN OF WYOMING

PROPOSAL OF THE

U.S. DEPARTMENT OF THE INTERIOR

PREPARED BY THE
ENVIRONMENTAL IMPACT ASSESSMENT PROJECT
OF THE INSTITUTE OF ECOLOGY

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Submitted to the Department of Interior

by the

Environmental Impact Assessment Project

of

The Institute of Ecology

Edited by

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August 2, 1974

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PREFACE

The Environmental Impact Assessment Project (EIAP) of The Institute of Ecology was established in July, 1973. Its aim is to increase the objectivity and improve the substantive content of federal environmental impact statements (EIS's) prepared by federal agencies pursuant to the National Environmental Policy Act and in accordance with Council on Environmental Quality guidelines. In pursuit of this goal, the EIAP has assembled a number of interdisciplinary teams of scientists and other experts in order to assess the content of specific draft environmental impact statements selected for review.

In June, 1974, the Department of the Interior released a massive, five-volume draft EIS on the proposed Development of Coal Resources in the Eastern Powder River Coal Basin of Wyoming. This EIS was jointly prepared by the Bureau of Land Management, the United States Forest Service, the United States Geological Survey, and the Interstate Commerce Commission. The EIS was intended to present an analysis of the broad, cumulative environmental impacts of coal development in this area of Wyoming plus detailed analyses of the specific impacts of four proposed mining and railroad constuction projects.

The Assessment Project chose to review this EIS not only because of the profound and potentially irreversible adverse environmental impacts resulting from the proposed coal development, but also because the intensive development of this western coal represents a potential major element in developing national energy policy.

Although a review team of competent scientists who were particularly knowledgeable about the Powder River Basin ecosystem was quickly assembled, the short public comment period allowed by the agencies prevented the comprehensive analysis necessary for a proposal of this magnitude. Nonetheless, the review team did prepare extensive comments and criticisms of the draft EIS and submitted the draft comments to the Interior Department in a timely fashion.

In the opinion of the Review Team, the Final EIS released by the Interior Department failed to adequately address many of the substantive comments submitted in the draft analysis prepared by the interdisciplinary team. For example, one of the major comments made and documented by many members of the Review Team was the failure of the draft EIS to develop and utilize an environmental data base sufficient to permit well-informed decisions significantly affecting a large ecosystem and the human environment. This data base was not adequately expanded in the Final EIS.

Therefore, the Environmental Impact Assessment Project has edited and published the following edition of the Review Team analysis. Concurrently, the Assessment Project joins the Review Team in strongly recommending that a new draft EIS be prepared on the Powder River coal development proposal and adequate time for review and comment be provided. Only such a renewed commitment will permit the involved federal agencies to comply with the spirit and the letter of the National Environmental Policy Act.

John S. Winder, Jr.
Director
Environmental Impact Assessment Project

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I. INTRODUCTION

The interdisciplinary team selected by the Environmental Impact Assessment Project has carefully reviewed the draft EIS on the Development of Coal Resources in the Eastern Powder River Coal Basin of Wyoming. The review represents an effort to provide constructive input into the agencies' environmental impact analysis both for this specific proposal and for similar future proposals. Generally, such input is used in revising the draft EIS and then issuing it as the final impact statement that precedes an agency action. However, in this case, the Project review team has concluded that the gaps and inconsistencies in this EIS are of such significance that a final statement should not be prepared at this time. Rather, the information and recommendations presented in this review should be used in preparing a new draft impact statement and final agency action on the proposed coal leasing program should be postponed.

The review team also wishes to make it clear that the criticisms contained in this document are not intended and should not be construed as criticisms of the capabilities or intentions of those persons who prepared the draft EIS. The review team also recognizes that the very short agency timetable allowed for preparation placed an impractical burden on the agency staff.

II. FRAMEWORK FOR THE REVIEW

The draft environmental impact statement on Development of Coal Resources in the Eastern Powder River Coal Basin of Wyoming was prepared in an effort to comply with the National Environmental Policy Act of 1970 (NEPA). NEPA sets forth the

following national policy objectives:

> to encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation...

The Act goes on to state in Section 101 the following national environmental policy:

> ...it is the continuing policy of the Federal Government, in cooperation with the State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

Congress further declared that is is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

> (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
> (2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
> (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;
> (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
> (6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The Congress explicitly recognized that "each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment."

Under Section 102(2)(C) of NEPA, agencies of the Federal Government shall, "include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official..." These statements must include analysis of environmental impact, effects which cannot be avoided, alternatives, relationship between short-term uses and maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitments.

The Project's review of this EIS has been guided by the intent and requirements of both Sections 101 and 102 of NEPA. The comments and recommendations are based on an assessment of how well the EIS fulfills these requirements.

Many of the basic objectives of Sections 101 and requirements of Section 102 have not been adequately recognized or complied with in this EIS. The magnitude of the statement's deficiencies has led the Project team to conclude that compilation of a meaningful final statement is not possible at this time and that the draft EIS should be completely revised. The most important deficiencies are identified in the topics reviewed below.

III. GENERAL CRITIQUE OF THE EIS

A. The Impact Statement in the NEPA Context

The draft impact statement in its present form shows little concern for these NEPA objectives: that the Federal Government, through the federal agencies, act as "trustee of the environment for succeeding generations," that is "attain the widest range of beneficial uses of the environment," that it "preserve historic, cultural and natural aspects of our national heritage," and that it achieve a balance which "will permit high standards of living and a wide sharing of life's amenities."

NEPA specifies that the EIS must consider long-run implications. This EIS does not consider impacts beyond 1990, although NEPRP figures project coal development beyond 200 (I-32). From the region's perspective, to cut off analysis by this arbitrary date excludes consideration of future generations. After 1990, different uses of the land, life styles, and quality of the environment may be expected. This is a particularly significant issue because coal development often follows a boom-and-bust cycle - a cycle predicted by the Interior Department to occur with western coal by the turn of the century.

Basic to the management policies of the Bureau of Land Management, the U.S. Forest Service, and to NEPA, is the multiple-use philosophy. Evidence of this philosophy and planning objective is noticably absent in the EIS. In analyzing the impact of coal development on existing uses of the land, the statement manifests a bias toward a single resource use, coal, thus de-emphasizing

agriculture and other multiple uses in the region. The final EIS should recognize the existing, renewable uses, such as agriculture that are present in the region: and coal development should be analyzed insofar as it could be made compatible with these uses. Such analyses would maximize and enhance beneficial uses and renewable resources of the region without degradation of the environment.

The EIS present a very narrow interpretation of historic, cultural, and natural aspects of the national heritage characteristic of the Powder River Basin. Archaeological resources do receive consideration as historically important, but the present cultural and natural aspects are almost completely ignored. The people who live in the region and produce from the land are a living system and a unique part of our heritage. The wildlife and water interrelationships are also an integral part of the total system in this region. The statement should present the planning measures and standards which could be enforced to maintain the existing interrelated systems and inherent productivity of the region.

Finally, the EIS does not balance impacts. The draft EIS should analyze the possible disproportionate economic and ecological costs to the Powder River region of supplying other regions' energy demand. The statement fails to articulate the real costs to the present residents of the region in terms either of dollars or degradation to the environment. Previous coal development in other areas raises considerable concern about the possible harm caused by coal development in a sparsely populated area such as the Powder River region. Citing vague

national energy demands as an excuse for regional development with little discussion of other national energy strategies may result in a decision which raises living standards elsewhere while degrading the quality of life in the Powder River region. Such a justification is particularly premature in light of current efforts to articulate a concise national energy strategy.

B. Eastern Powder River Basin Coal and Federal Coal Leasing Policy

Neither the national energy situation nor the national coal picture is as simple as this draft EIS would indicate. It is apparent from this EIS (as well as from the current draft EIS on federal coal leasing)* that the BLM, USFS, USGS and ICC have completely adopted the conventional but debatable view that large-scale coal development is necessary, desirable, and inevitable. Many alternative options for the nations's coal development have been completely ignored in this EIS.

Significantly, this draft EIS comes at a time when federal coal policy is being widely debated -- in the Department of the Interior, in Congress, and by the public. Indeed, shortly before the issuance of this EIS, the Department of Interior released its draft programmatic EIS on federal coal leasing. In addition, as this review is published, Congress has completed the final stages of debate on the regulation of coal strip mining.

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*The Environmental Impact Assessment Project is currently conducting a review of the Federal Coal Leasing EIS.

Widespread public concern encompasses a number of issues, including the potential impacts of rapid western coal development, possible coal industry abandonment of eastern mines, the realtionship of coal development to the national energy strategy that may emerge from competing federal agencies and programs.

Notwithstanding such far-reaching and important coal policy considerations, it is clear that this EIS was written in a virtual vacuum. The future of federal coal management and the rules under which coal can be stripped are at stake. Yet this EIS deals with the development of Wyoming's Powder River Basin as if it were unrelated to such policy matters.

The EIS contains some allusion to the fact that federal coal management has been less than adequate in the past. Large numbers of outstanding prospecting permits reveal the precarious overcommitment to coal development made by the Interior Department. For many years, these permits were issued for coal "exploration" in the areas of the thickest strippable coal deposits in Wyoming. "Finding" such coal deposits permits avoidance of competitive bidding and thus leasing at less than fair market value. Moreover, granting of leases may permit coal development timing decisions, with the attendant adverse impacts, to be made by private companies rather than by federal, state, or local officials.

Neither this EIS nor the draft statement on the proposed federal coal leasing program indicate that past mistakes will be recognized or corrected by new federal coal management policies and programs. Both EIS's graphically illustrate the In-

terior Department's lack of commitment to objectively assess federal coal development problems and to incorporate environmental factors into this critical decision-making process. Furthermore, both impact statements fail to weigh the potential development of privately-held or eastern coal deposits against the intense speed-up of western coal development as urged by industry, the Interior Department, the USFS, and the ICC.

C. Regional and Site Specific Analysis

The approach of the statement is to present both a regional and site-specific analyses, yet, the two analytical approaches are not consistently related. The statement thus fails to satisfy either regional analysis or site-specific evaluation criteria.

Furthermore, the EIS designation of an "East Powder River Coal Basin" is misleading. The Powder River Basin is a hydrologic basin and includes most of northeast Wyoming. A regional analysis of coal development based on coal resource definitions would cover a three-state area. If the immediate off-site impacts were included, the area covered would be the five states included in the Northern Great Plains Resources Program.

An impression of minimal impact is created by using a reference base covering a large area of the region, which then gives a low percentage figure for the actual impact area. The most glaring examples of this

"minimizing impacts pattern" are found in discussions of air quality impacts, water availability, and the importance of agriculture.

The concept of a regional analysis has not been clearly defined in the EIS and, in fact, is arbitrary and inconsistent from one section to the next for a single resource. Area or number reference (plants, mines, reservoirs, etc.) appear to change from one page to the next. This problem is aggravated by the constant shifting in measurement units, and the apparent transposition of figures and tables so that these fail to correspond with the text. Specific examples of each of these problems are presented in the discipline critiques presented below.

A major objection to the analysis of accumulated regional impacts section is the fragmented way in which it is presented. The EIS should make more use of summaries and a concise presentation of major adverse impacts and anticipated effects on existing landscapes, in order to facilitate an accurate appraisal of the total costs and benefits of probable courses of action.

D. Adequacy of Data

An environmental impact statement should utilize the most accurate predictions possible. Underestimating impacts may set in motion an irreversible program of development while a more accurate knowledge of impacts would not have allowed it to begin. Although making predictions is difficult, it is essential that the mechanisms and data base for making these predictions be clearly described. Because neither the models nor the data have been clearly outlined in the EIS, little confidence can be placed in the predictions.

Related to this problem of accuracy of prediction is the apparently narrow information base from which the EIS was developed. The Northern Great Plains Resources Program is widely known as an on-going evaluation of resource development over the entire Northern Great Plains. Yet, the information from this project was not used extensively. Information should also have been used from the International Biological Program Grassland Biome Project in the Pawnee National Grassland in northeastern Colorado. This project has been studying the grassland ecosystem for six years in an environment similar to that of Powder River, during which time over 250 technical reports and numerous publications have been prepared, including the development of a mathematical simulation model (ELM) to ascertain the effects of various perturbations on the grassland environment. Yet this study, supported by the National Science Foundation, is not even referred to in the five-volume EIS. These are just two examples of extensive sources of information which could have been used to fill in the many gaps in this EIS.

In addition to omitting several sources of information, the EIS does not present or assess the scope and magnitude of various impacts. Data in critical areas is lacking, conflicting, or not presented in an intelligible perspective. The EIS does not make clear what changes may occur to air, land, and water from the proposed developments.

Furthermore, while the impact of various activities is considered on vegetation, wildlife, aesthetics, etc., no attention is given to the effect of the spatial distribution or time sequencing of these activities. Consider an area with a rail-

road track, a mine, a power plant, and a town. One spatial arrangement of these components might lead to greater environmental impact than another and it would be desirable to specify the distances between the components necessary to mitigate adverse impacts. The statement often fails to identify significant proportions -- oftentimes no figures are given, as in the statement "Strip mining and associated activities will eliminate a portion of this life-support community which is the major irreversible impact to wildlife in this area" (III-170).

The timing of events, either natural or man-caused, should also have been given greater consideration in the impact statement. Analysis of timing would facilitate evaluation of a communitiy's ability to deal with impending impacts.

Finally, the information is often poorly presented. On the one hand, the EIS presents very technical information which is neither interpreted nor related in many cases to the immediate discussion or other sections of the statement. On the other hand, generalities and vague statements are presented without documentation.

E. Evaluation of Environmental Impacts

The mitigation section of the EIS is narrowly conceived. Moreover, there is no presentation or analysis of the environmental controls, if any, written into the existing leases. This section appears to make the general assumption that existing federal and state laws and regulations are the measure of what is acceptable and that those standards are the only ones available to the agencies.

In fact, existing laws are scattered and cover only portions of environmental impact - using only federal standards may degrade environmental quality instead of maintaining or improving it. Certainly the thrust of NEPA and of EIS's is to minimize environmental degradation. Department of Interior does have power to write leases which would protect or restore the impacted areas.

F. Public Hearings

At the time of public hearings, the commenting groups did not have available to them critical information which would have been the basis for more objective input. Some of this information was available but not used in the EIS. The information that was included in the statement is often conflicting, and more critical research still needs to be done. Furthermore, the review time prior to public hearings was insufficient to permit review of the document and preparation of comments. Because public input is an essential part of the decision-making process and because this input should be more than a superficial evaluation, there should be public hearings again following the rewrite of this EIS.

G. Moratorium

Based on the many research gaps identified in this review, and in light of the potentially massive adverse environmental impacts at stake, it is recommended that there be a moratorium on any decisions to proceed with this proposal. This moratorium would allow time to prove or disprove some of the generalizations set forth in the draft, and time necessary to analyze critical areas which at this time lack research and documentation.

IV. Disciplinary Reviews

A. Climate and Air Quality

The draft EIS cites an EPA study which indicates that 15 potential pollution episodes, each lasting at least 2 days when an inversion exists near the surface, can be expected over the Basin each year. This study was based on routine National Weather Service atmospheric soundings at Rapid City, Scottsbluff, Denver and Lander, but these are unrepresentative of the atmospheric boundary layer in the vicinity of the Bighorn Mountains. Observations conducted by the University of Wyoming suggest that there will be one episode lasting at least 6 months each year since there is a persistent inversion over the area during the winter from cold air which drains across the low altitude continental divide near Rawlins. This cold air accelerates, producing the strong, persistent winds in Casper and then spreads across the Basin. When the Rawlins air is not producing an inversion, arctic air masses with cold north winds spread over the area and also produce a low inversion.

The atmospheric boundary layer is critically important in air quality. Since the mountains strongly affect the boundary layer, this area must be studied in detail, and patterns should not be interpolated from existing National Weather Service data on other areas. Before any power plants are allowed to come on line, and begin to deteriorate the air quality, the local weather pattern must be analyzed.

An example of the connection between the unique boundary layer which exists over eastern Wyoming during the winter and

air pollution is given in Figures 1 and 2. Figure 1 is a vertical temperature profile taken along a north-south line through Douglas on 6 December 1973. There is a well-defined inversion at about 800 feet above ground level. As is common for this area, the diagrammed inversion persisted for several days and did not break. Figure 2 is a plot of the vertical temperature distribution and horizontal wind profile. The atmosphere is stably stratified. The unique characteristic of the boundary layer is demonstrated in Figure 2. The winds at the surface are about 20 mph, while the winds at 400 feet exceed 60 mph. Typically low level jets associated with inversions occur above the inversion. Since the boundary layer is stably stratified and over a sloping terrain, it is believed that in such a case the cold, dense air below the inversion accelerates the most, thereby producing the unique low level jet below the inversion.

Serious consideration must also be given to the possiblity of inadvertent weather modification and its impacts caused by excess human activity in a semiarid region. In India the evidence indicates that a desert has been caused by nomads who overgrazed the land. Dust rose in the atmosphere and acted as a black body. Solar radiation was absorbed by the dust (black body) rather than at the earth's surface (Bryson, 1972). When the atmosphere is heated from below, it becomes unstable and convective clouds form (similar to boiling of water) and causes summer rain. When the atmosphere is heated in the mid levels, the atmosphere is stabilized and a drought ensues. This has happened twice in India. It now seems to be happening along the southern edge of the Sahara Desert in Africa where well-intentioned

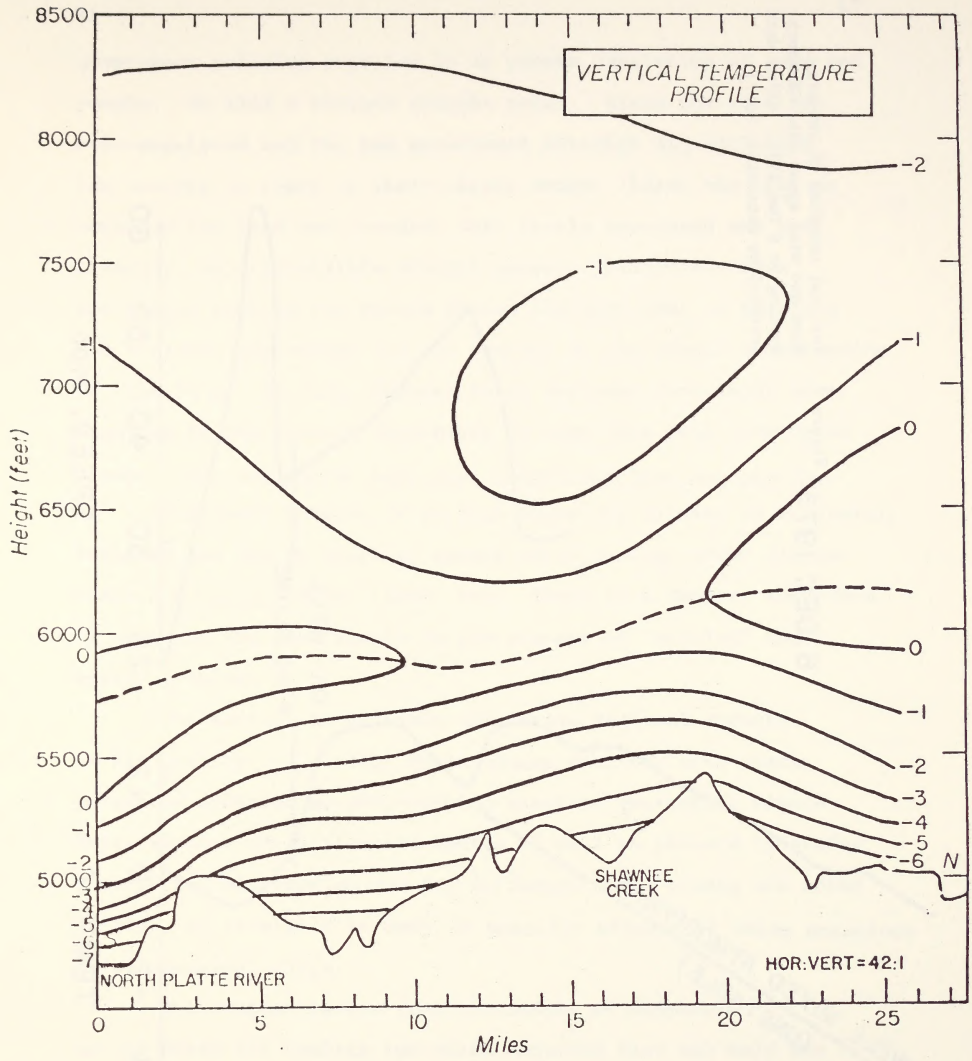

Figure 1. Douglas site temperature cross section, 6 December 1973, morning (0800-1000) with southwesterly winds. Temperature is in degrees Centigrade. Dashed line represents top of stable layer. (Data provided by Metronics, Inc., California).

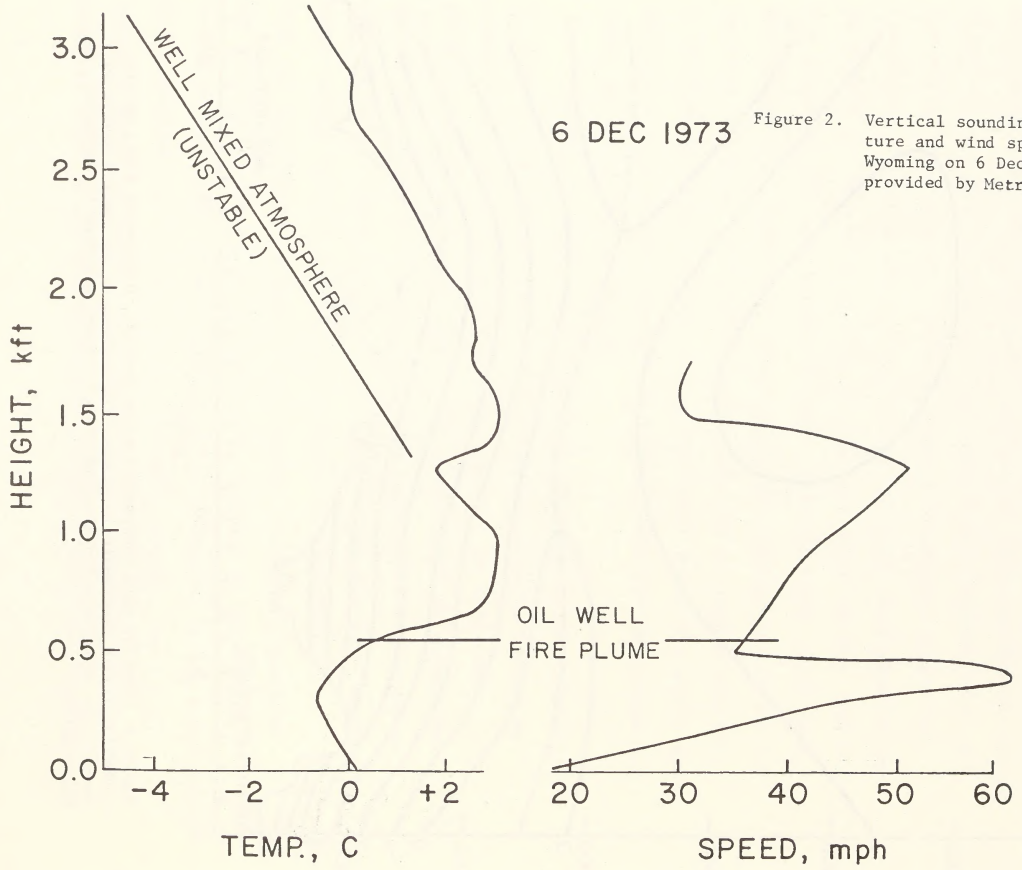

Figure 2. Vertical sounding of temperature and wind speed near Glenrock, Wyoming on 6 Dec 1973. (Wind data provided by Metronics, Inc.)

government policies resulted in an excess population of cows and people. In 1968 a routine drought began. Since the area was over-populated and the new government policies did not allow the natives to react in their normal manner (leave the area as nomads), the land was denuded, dust levels increased and now, possibly, an irreversible drought exists. Scientists have speculated that in the United States the dust bowl in the 30's was at least aggravated (if not caused) by the excess homesteading of the 20's. In fact, Thunder Basin National Grasslands were acquired by the Federal Government to keep this area from being plowed, thus preventing dust bowl conditions from encroaching.

Northeast Wyoming is an area where the climate is delicately balanced and can be upset by excess strip mining, power plants, roads, railroads, power lines, etc. There is a danger, therefore, of reducing the food supply in the process of "solving" the energy problem.

The section on Probable Cumulative Regional Impacts on Air Quality (II, I-461) deals almost entirely with stack emissions produced by coal-burning electric generating plants. While amounts of particulate matter as well as amounts of sulfur dioxide and nitrogen oxides for different power plants are noted (I-647), no reference is made to specific effects of these emissions on agricultural flora.

The Project review team recommends an amendment to the State Air Quality law which requires that not only the amount of allowable particulate matter be delineated but also the composition of that particulate matter. It is extremely critical that the components of particulate matter be recognized

so that any changes which appear in biological systems can be correlated with specific chemicals in the air.

Current Wyoming Air Quality Regulations require only that not more than a certain amount of particulate matter be released into the air. It is essential that particulate collectors be located at a considerable distance from dirt roads and on the same sites from which biological data is being gathered. The composition of particulate matter must also be delineated to permit a determination of distance travelled by stack emissions and to differentiate between emissions from power plants and those from other sources.

B. Soils

The soils data is misleading and inadequate. The area soil association map (Map 7, Appendix) is too vague and generalized to give any more than a very cursory overview of the study area. A more detailed and comprehensive map is needed for adequate planning and assessment.

The study area is reported to contain 4,978,560 acres (I-16). The total acreage of the 21 area soil associations contains only 4,668,780 acres. This is a difference in excess of six percent of the total. It is not clear whether the missing six per-cent is included in lands listed as "miscellaneous areas" unable to be classified. If so, Map 7 shows no gaps for the unclassified areas.

Although considerable agricultural soil-survey information is presented, there is no description of the subsurface mineralogy, soil depths, and degree of zonation. These are critical to assessing probability of reclamation and methodologies for

soil stockpiling and rehabilitation. The regional soils map in the Appendix permits the following notation:

> Of the coal mine areas outlined on appendix maps, only a few of the loosely-mapped soil associations are to be involved in rehabilitation efforts and mining disturbance. These are:
>
> Unit #1 - about 5% of the mine areas
> Unit #3 - about 40% of the mine areas
> Unit #7 - about 15% of the mine areas
> Unit #8 - about 10% of the mine areas
> Unit #11 - about 30% of the mine areas

Of these, 55% are highly erodable by fluvial processes (running water) and an additional 5% by wind. The remaining 40% are all classed as of moderate to high fluvial erosion hazard. The 5% wind-erodable are noted to be within floodplains or subject to periodic flooding. Unit #11 has high shrink-swell hazard. Most have low permeability and are all of varying thicknesses. These figures indicate that the handling of the soils to be directly impacted by mining must be quite different than the EIS suggests. The soils to be impacted are delicate and must maintain their cover if they are to be kept out of the watercourses. They are not conventionally irrigable once soil structures are destroyed by stripping and stockpiling. The EIS implies that soil formation will begin again once mining has ceased and reclamation has been completed (I-651). However, probably the most critical factor in initiating pedogenesis on the spoils piles will be vegetation. Without adequate plant cover, wind and water erosion may be sufficient to maintain the spoils piles as rubble. It is questionable whether sufficient water is naturally available for adequate revegetation.

The EIS does not outline the geologic history of the soil units - how old the soils are or how immature they may be. This can only be derived from first-hand knowledge of the soil association units. The surficial geologic information is not geomorphic, i.e., it does not tell the reader how that landform and its associated soil and vegetation were formed. One cannot, therefore, know how it will behave when disturbed and recontoured.

Lack of sensitivity to the problems of rehabilitation is also evident in the quality of soils data presented. Most was drawn from existing agricultural sources and is of very little help for strip-mine reclamation analysis. The soils information therefore does not provide a solid basis for decisions on reclamation. Data required would include percentages of vegetative cover, kinds of vegetative cover as a function of soil unit, soil mineralogy, soil depth, and soil texture. These should be superimposed on a landform map showing soils actively forming, accumulating, or eroding so that past and future impacts can be assessed.

This EIS provides some long-needed information on climatology that should be coupled with adequate soils data to give an accurate assessment of reclamation potential. The EIS does contain an implicit suggestion of a reasonable goal or definition of reclamation, for example, "Land will be reclaimed to a terrain compatible with present topography and planted to provide soil stability and re-establish a viable land use," and "Reclamation objectives are to return the land to a realistically attainable land use" (I-80). Whether a 'viable land use' is necessarily 'realistically attainable'

is subject to considerable discussion. If viable means in perpetuity, then it must be a natural functioning ecosystem adapted to local conditions and variations.

The EIS quotes from the National Academy study in part:

> This (adequate rainfall for vegetation establishment) has been demonstrated in rangeland seeding projects through this region. Predicting such results assumes that the best technology will be applied, including the addition of topsoil and selective sorting of spoils to avoid placement of clays and toxic substances on or near the surface. *

Nowhere, however, is such a handling procedure specified in the EIS. There is nothing about selective sorting; on the contrary, large earthmoving equipment is to be used indiscriminantly on the 5-60" soil layers for collection of the soil.

The EIS (I-79) concedes that disruption of soil structure and accompanying loss of fertility preclude re-establishment of near-climax types of species or cover. It does not say how it determines what such climax conditions may be nor even if they exist at all in undisturbed sites. (They probably do not exist, given the pedologic immaturity of the area.)

The importance of the extremes in precipitation is not properly emphasized in the EIS. While the mean annual precipitation is about 12", it is only that high because there are a few extremely wet years. The actual precipitation distribution is skewed such that about 1/2 of the years receive less than 10" of total precipitation. (10" is the figure cited in the National Academy study as necessary for reclamation.)

The precipitation to evapotranspiration data given (P-PET), on pp I-124-5 and Table 9 of Appendix C, reveal that there is a considerable moisture deficit during the growing season. All

*(Rehabilitation Potential of Western Coal Lands, National Academy of Science, Washington, D.C., 1974.)

moisture that falls on the ground during the growing season is consumed by plants or evaporates under undisturbed conditions. An additional amount of winter moisture is also consumed. No excess water is available in the top 6" of soil to recharge aquifers at the end of the growing season. Actual evapotranspiration is almost twice precipitation for a year and is three times the precipitation during the growing season. There is therefore a moisture deficit and plants exist in rangeland conditions by their ability to augment the ability of natural soils to trap and store moisture. Artificially-built soils do not have such abilities. If devegetated but not stockpiled, as in farmland succession, soils become more dense, resist percolation by water, have higher bulk densities, and support less groundcover until the very slow process of plant succession permits roots to reach progressively greater depths and to accumulate organic matter at these depths. Such plant succession is evident in the work of Lee Lang. The EIS quotes his 1940's thesis which states that 50 years would see recovery, but his 1973 work showed that prediction to be erroneous and that such recovery will take longer.

Work done on farmland is not applicable to coal-mined land reclamation, primarily because in the farmland situation, the soil layers are not as thoroughly mixed as they are in the strip-mine stockpiling situation. Thus, subsoil structure and some soil zonation is retained in the farms; all that has to be done is to restore the lower bulk densities of the soil and thus improve its absorption and storage of water. "Viable" land use reclamation means that soil zonation must be restored by

natural processes if not prescribed in the mining plans. Natural soil zonation processes take thousands of years.

The "50% loss in productivity" conclusion of the EIS is based on the farmland reseeding experiments and studies typified by Figure 6 (I-506). This study follows from Lang's 1973 observations of build-up and decline of cover 45 years after farmland abandonment in which present cover is but 43% of that on adjacent 'undisturbed' lands. The 50% figure for the proposed program cannot be supported since it is not based upon reclaimed mined lands. By 1980 a total of 8,900 acres are to be permanently lost to vegetative cover (I-504), or 31 per-cent of the total disturbed by then. The 50 per-cent reduction figure is for productivity of the remaining potentially reclaimable land. Therefore, only 34 per-cent of the disturbed land is to be brought back into a semblance of predisturbed productivity after 50 years.

There is absolutely no basis for proposing that there will be an increase, not decrease, in land productivity except during that implied by the 5-year period of stewardship through fertilization, irrigation, and reseeding during which 'reclamation is ongoing.' However, such fertilization and irrigation is of very limited duration and will ultimately reslt in very sterile conditions on the reclaimed soils.

There is no basis for the figure of 4,036 acres of "rehabilitated" land in the 5 years from 1980 to 1985. Lang's charts clearly do not support it. Ninety-two per-cent of the acreage to be disturbed is dominated by sage (I-505) which could not be expected to recover to even 10% of its original

cover after five years.

C. Geochemistry

1. Description of the Existing Environment

a. Considerable potentially harmful trace elements are noted in the chemical analyses provided in the EIS. However, the conclusions of the EIS do not follow from the data presented. Particular care must be taken with molybdenum, selenium, mercury, and fluorine. The figures provided do not permit calculation of aggregate averages of these elements for the total coal to be burned in various areas or in various plants; therefore airshed modeling and dispersion alalyses are not possible except using hypothetical figures, from which true impacts cannot be derived.

b. The fluorine values given, in particular, suggest high potential fluorine pollution in downwind grazing areas, with associated fluoridosis poisoning. Perennial grasslands and conifers are much more susceptible to fluorine build-up than are broadleaved trees in the East.

Using the EIS figures for fluorine concentrations (with a simple average of 57 ppm for all samples listed on page I-177) and noting that a cumulative total of 373 million tons of coal are to be consumed within the basin, which is but a small fraction of the cumulative totals expected by the year 2000 (I-33; 285.7 million tons/year total production); about 21,261 tons of fluorine may potentially accumulate in the basin from mine-mouth and nearby power plants. Over a 15-year period, this amounts to an annual production of fluorine of about 1417 tons or more than three times the peak annual fluorine output of Anaconda Aluminum Company of Columbia Falls, Montana,

with its very well-documented fluoride injury to 15,200 acres around that plant. (See TIE Review of Crow Ceded Area, pages 34-35). Coupled with SO_x discharges, these emissions should have considerable impact on the southeastern half of the Powder River Basin and will impact grazing of cattle as fluorine accumulates in the forbs. Moreover, if the values of 200 ppm fluorine reported for one sample are more typical than the EIS data suggests, the fluorine contents of Atlantic Richfield and Carter Oil coal holdings suggest average concentrations in excess of 100 ppm. Fluoride outputs from burning that coal would thus be double those of the conservative model developed here.

c. The impact statement noted (III-12), "Preliminary tests indicate the overburden does not contain any toxic materials." However, the EIS (III-45) indicates potential problems with respect to boron and lead; other analyses presented in Table I show local high concentrations of molybdenum, beryllium, and cadmium; and botanical research has reported the presence of selenium converter plants, indicating a possible selenium problem. The local high concentrations of these elements appear quite sporadic in occurrence. More analyses of the overburden should be made, so that areas with high concentrations of toxic elements can be located, and measures can be taken to prevent these elements from being released to the environment.

Molybdenum acts similarly to selenium in affecting ungulate milk production and may be accumulative downwind, so the cumulative effects of both these elements could be extremely adverse. Antelope may be more susceptible than domestic cattle.

Table 1. ANALYSES OF COAL AND OVERBURDEN ROCKS: RANGES AND AVERAGES FOR FIVE NON-VOLATILE ELEMENTS (IN PPM)

Core #	(Ft) Depth Range	Type	Number Samples	Cu Min.	Cu Max.	Cu Av.	Pb Min.	Pb Max.	Pb Ave.	Cd Min.	Cd Max.	Cd Ave.	Be Min.	Be Max.	Be Ave.	Mo Min	Mo Max	Mo Av
BT 87	59-127	Coal*	12	2	130	28	5	50	**	<0.2	4	<0.2	0.1	3	0.4	<1	13	2
BT 104	81-129	Coal	22	3	70	11	5	10	**	<0.2	1	<0.2	0.1	1.7	0.4	<1	15	3
BT 109	11-101	Over-burden	16	3	100	35	5	50	**	<0.5	4	1.6	1.5	8	3.7	<5	30	9
BT 109	102-175	Coal	8	5	30	9	5	8	**	<0.2	< 0.2	<0.2	0.1	1	0.3	<1	3	<1
BT 109	175-207	Under-Burden	8	4	130	50	<5	50	**	<2	5	2	1	10	6	<5	15	9
BT 111	11- 74	Over-Burden	13	10	80	25	10	50	**	<2	7+	1	1	5	3	<5	15	4
BT 111	74-144	Coal	7	7	11	9	4	7	**	<0.2	<0.2	<0.2	0.1	0.6	0.3	<1	2	1
BT 111	144-153	Under-Burden	2	20	25	22	5	40	**	<0.2	2.5	1.3	4	7	5	3	6	4
Coal/shale Reported avrage abundances					15/45			25/20			-/0.3			3/3			5/2.5	

*One sample had 50% ash and much higher metal content

**Lead results are uncertain at this time; polarographic analysis has established ranges.

+one sample in this series read 50 ppm cd, confirmed polarographically.

Notes 1. We are in process of analyzing for volatile elements, and are not prepared to release figures at this time.
2. Leading experiments are under way, but are not yet completed.

FROM: Forthcoming Research Report, Department of Geology, University of Wyoming, by Dr. Ronald Surdham

Mercury is a well-known poison that becomes airborne through coal combustion. Little is known of its fate after it leaves a stack. Coal partings are noteworthy places for concentrations of mercury and uranium.

Since toxic elements may be leached from the disturbed overburden, it is strongly recommended that trace element concentrations be monitored in ground waters surrounding the site, and in surface waters downstream from the site.

d. Highly variable chemical values obtained at single well sites (Table 2) may present problems to hydrologic interpretations when they are based on single values.

2. Probable Impact

a. The EIS (III-13) does not note that pumping water from the pit into Little Thunder Creek will raise the salinity of the creek, and will probably make the water downstream from the mine unsuitable for livestock and wildlife use. Salinity is a relatively minor and local problem when the ARCO mine is considered in isolation, but the cumulative effect of all the proposed operations in the region on surface water quality could be very significant.

Any ground water that is released into the surface drainage will cause severe deterioration of the surface water quality. The ground water, with respect to major ions, is of very poor quality (average approximately 2,000 ppm total dissolved solids - see Table 3a and 3b). For a frame of reference, the recent controversy between Mexico and the United States over the quality of water delivered by the Colorado River concerned an increase from 850 to nearly 1500 ppm total

Table 2. Comparisons of well analyses

Sample #/Date/ T-U	Ca	Mg	Na	SO_4	HCO_3	Cl
R-8/7-3-73/Them	305	123	410	1670	475	25
R-8/7-11-73/Them	72	34	260	210	780	25
R-8/9-19-73/Them	43	27	235	11	800	59
R-8/12-3-73/Us	26	27	249	180	576	13
R-156/10-9-73/Them	152	80	68	660	162	16
R-156/12-3-73/US	247	103	100	808	451	1.7
R-153/7-27-73/Them	305	114	126	1050	450	30
R-153/12-3/73/Us	203	76	85	883	---	15
Reserv/4-16-73/Them	57	21	35	160	135	20
Reserv/12-3-73/Us	48	22	58	215	120	1.4
W-4/10-3-73/Them	385	346	764	3200	647	113
W-4/12-3-73/Us	484	479	700	3456	632	183
W-2/3-31-73/Them	710	230	340	3100	200	47
W-2/2-26-74/Us	458	222	155	1900	533	14
W-10/5-8-73/Them	100	66	420	990	433	34
W-10/2-26-74/Us	128	56	395	830	678	7
R-151/7-27-73/Them	220	80	180	650	520	40
R-151/2-26-74/Us	203	83	90	565	560	8
R-14/5-24-73/Them	119	20	375	380	872	60
R-14/2!26!74/Us	97	33	300	355	800	9
CBS/3-22-73/Them	137	50	60	450	205	30
CE/2-26-74/Us	120	45	54	400	235	3

FROM: Forthcoming Reseach Report, Department of Geology, University of Wyoming, Dr. Robert Surdham

Table 3. Extreme and Average Major Element Compositions of Selected Well Waters and Surface Waters (PPM)

A. Sample Type: Wasatch Wells
Number Samples: 15 (6 'us' + 9 'them')

Element:	Min	Max	Av
Ca	8	710	210
Mg	20	480	125
Na	200	765	375
SO_4	35	3500	1280
Cl	7	180	50
HCO_3	150	800	500
SiO_2	5	20	10
TDS	675	6000	2200

B. Sample Type: Roland Wells
Number Samples: 22 (9 'us' + 13 'them')

Element	Min	Max	Av
Ca	25	380	170
Mg	18	210	75
Na	60	500	235
SO_4	50	1670	650
Cl	1	60	25
HCO_3	165	1240	580
SiO_2	6	30	13
TDS	500	2800	1630

C. Sample Type: Surface
Number Samples: 6 (2 'us' + 4 'them')

Element	Min	Max	Av.
Ca	39	310	120
Mg	6	110	42
Na	35	230	80
SO_4	125	1370	450
Cl	1	60	20
HCO_3	60	275	170
SiO_2	<1	15	4
TDS	230	2370	880

D. Surface: Thunder Crk only + Reserv.
5 samples (2 'us' + 3 'them')

Element	Min	Max	Av.
Ca	39	137	80
Mg	6	50	29
Na	35	60	48
SO_4	125	450	270
Cl	1	30	13
HCO_3	60	235	150
SiO_2	<1	15	5
TDS	230	920	600

FROM: Forthcoming Research Report, Department of Geology, University of Wyoming, by Dr. Robert Surdham

Table 4

COMPARISON OF CHEMICAL CONSTITUENTS IN THE DRINKING WATER STANDARDS OF THE WORLD HEALTH ORGANIZATION AND THE U.S. PUBLIC HEALTH SERVICE

Concentrations In Milligrams Per Liter

	WHO International (1958)			*WHO European (1961)*		*U.S.P.H.S. (1962)*	
Chemical Constituent	*Permissible Limit*	*Excessive Limit*	*Maximum Allowable*	*Recommended Limit*	*Tolerance Limit*	*Recommended Limit*	*Maximum Allowable*
Alkyl benzene sulfonate	--	--	--	--	--	0.5	--
Ammonia (NH_4)	--	--	--	0.5	--	--	--
Arsenic	--	--	0.2	--	0.2	0.01	0.05
Barium	--	--	--	--	--	--	1.0
Cadmium	--	--	--	--	0.05	--	0.01
Calcium	75	200	--	--	--	--	--
Carbon chloroform extract	--	--	--	--	--	0.2	--
Chloride	200	600	--	350	--	250	--
Chromium (hexavalent)	--	--	0.05	--	0.05	--	0.05
Copper	1.0	1.5	--	3.0*	--	1.0	--
Cyanide	--	--	0.01	--	0.01	0.01	0.2
Fluoride	--	--	--	1.5	--	0.8-1.7#	1.6-3.4#
Iron	0.3	1.0	--	0.1	--	0.3	--
Lead	--	--	0.1	--	0.1	--	0.05
Magnesium	50	150	--	125**	--	--	--
Magnesium + Sodium sulfate	500	1000	--	--	--	--	--
Manganese	0.1	0.5	--	0.1	--	0.05	--
Nitrate (as NO_3)	--	--	--	50	--	45	--
Oxygen, dissolved (minimum)	--	--	--	5.0	--	--	--
Phenolic compounds (as phenols)	0.001	0.002	--	0.001	--	0.001	--
Selenium	--	--	0.05	--	0.05	--	0.01
Silver	--	--	--	--	--	--	0.05
Sulfate	200	400	--	250	--	250	--
Total solids	500	1500	--	--	--	500	--
Zinc	5.0	15	--	5.0	--	5.0	--

* After 16 hours contact with new pipes; but water entering a distribution system should have less than 0.05 mg/l of copper.
** If there are 250 mg/l of sulfate present, magnesium should not exceed 30 mg/l.
\# Recommended limits and maximum allowable concentrations vary inversely with mean annual temperature. See table 5-1.

dissolved solids. The Mexicans found the higher figure to be unsuitable for irrigation and the government of Mexico lodged a formal protest precipitating an international incident.

The surface water, on the other hand, with the exception of one very minor tributary, is of relatively good quality (average approximately 700 ppm dissolved solids - see Tables 3d and 4).

Ground water will be discharged into the surface water by tapping the Roland Seam, a regional aquifer, during the mining operation. The degredation of surface water will be especially high during the summer months when surface drainage is low and the rate of evaporation is high. Inevitable evaporation in the Powder River Basin will make waters such as those characterizing the Wasatch Formation (Table 3a) and the Roland Seam (Table 3b) unsuitable for irrigation. Degradation of water quality should be discussed in more detail in the impact statement and ARCO's many analyses of ground waters from the coal and overburden should be included in the analysis.

b. On page III-130, it is stated that irrigation will be used, if necessary, to re-establish vegetation, but the proposed source of irrigation water is not mentioned. In view of its salinity and sodium content, the suitability of the local ground water for irrigation is questionable. The EIS should be more specific as to the feasibility of irrigation, particularly because irrigation is likely to be needed in the event of a general drought, at which time other demands for water will be high, and supplies will be at a minimum.

c. The EIS should discuss the problem of acid rain resulting from SO_2 release from generating plants and gasification

plants. A recent article in Science (v. 184, p. 1176-1179, June 14, 1974) documents acid rain as a serious environmental problem in the northeast United States.

3. Mitigating Measures

The only way to avoid degradation of surface water quality would be to contain all waters pumped from the pit so they would not be released into the environment. The review team also recommends that monitoring stations be set up at the mine and at several points downstream from the mine in order to monitor these effects.

D. Water Resources

Although the water section of the EIS presents both figures and descriptions, it is inadequate, unclear, conflicting and, in places, not based in fact. Estimates for groundwater are probably too high. Surface water resources are not fully discussed in terms of availability, changes in use or the impacts of both in-basin and trans-basin diversions. Thus the impact for northeast Wyoming and for other areas of the State which may lose water to Powder River Basin coal development cannot be assessed.

The impact statement claims both water scarcity and apparent abundance. Most of the figures used in describing water resources have come from the Wyoming Water Plan; little new or interpretive information has been added. The tables and charts showing irrigated acres, filings for new reservoirs, compact percentages, etc., are not related to the industrial water uses for the region or for specific development. The

EIS should show where excess surface and underground waters exist, where water will be needed for coal development, how it will be transported, who and what is impacted in the process, and whether water rights should be transferred from agriculture to industry. The BLM should also compare present storage and future storage as they relate to yearly fluctuations, stream flows, and evaporation.

The EIS is inconsistent in its inclusion of rivers for description and impact analysis throughout different sections of the statement. The latest Wyoming Water Plan shows considerably less available water for the two-county study area than is suggested in the EIS (I-54). Further information is necessary to determine how much can be withdrawn under the "safe yield" concept.

The EIS should discuss the water quality and quantity changes which will occur with the mining of aquifers. Aside from mention of impacts on a few nearby wells, this draft statement does not discuss the alkali lakes which will form in mine cuts or the leaching of trace elements into water supplies. The statement should also treat the effect of dumping saline Green River water into the Powder River Basin. The statement should make use of recent research on the Decker Mine in Montana which documents seepage of surface and near-surface waters into mine pits and associated water degradation.

The EIS summary section on water impacts in the Powder River Basin (I-502-503) clearly supports the conclusion of the Assessment Project review team that this EIS does not adequately assess the impact of water use or the impact of coal development on water quality.

E. Biota: Vegetation; Wildlife and Fish

1. Introduction

In order to assess the impact of coal development on natural ecosystems, certain baseline information on biota is essential.

First, the EIS should present a quantitative description of the vegetation, including measurements of productivity, in habitats representative of the area to be disturbed, and population estimates, as well as resource requirements for economically important species such as game birds, game mammals, game fish, and major predators and furbearers. These figures are essential for a cost-benefit analysis.

Second, the species' richness, relative abundance, general resource requirements, and trophic relationships of vertebrate and invertebrate species functioning as integral components of the ecosystem should be presented.

Quantitative description of representative soil communities, including taxa present, their relative abundance, trophic relationships, and decomposition rates should also be included.

Finally, the EIS should present population estimates and distributions of rare and endangered species. In addition, because of the cyclic nature of plant productivity and animal populations, all the estimates should be collected over a period of several years.

Once the appropriate data have been gathered, variables introduced by the proposed development must be specified: e.g., changes in drainage patterns, potential toxic

elements in overburden, emissions, etc. Small-scale experiments should be performed to assess the effect of major introduced variables on the major components of the ecosystems and on the relationships between components.

Research and data collection should be used in the construction of a general ecosystem model. Such a model could then be used to predict the effect of various types of disturbance on the ecosystem and its components.

2. Vegetation

a. Adequacy of description

The origin of the frequently cited fifty per-cent vegetation reduction figure is not clear, and the EIS gives no data to support the figure.

Moreover, this fifty per-cent figure is used in different ways. For example, the following statements are made: "There will be a fifty per-cent loss in productivity for grazing purposes" (I-59), "The total vegetative cover will be greatly reduced, probably near fifty per-cent of that found on adjacent undisturbed range" (I-523), "Long-term productivity of this land will be lowered by fifty per-cent, or 2,600 animal unit months per year" (I-861). Also, no source is given for the productivity estimates (I-143). Values are given for soil conditions, which represent the extremes. There is little consideration of the productivity on the average site to be stripmined, or the cycling and biomass dynamics of the current vegetation.

Further, there is no data on current productivity of each vegetation type and no data on species' relative abundance. Such data are important for planning and evaluating rehabilitation

success. Though rare and endangered species are considered under wildlife, no mention is made of rare and endangered plant species and habitats.

The report is accurate in recognizing the importance of the negative precipitation-evaporation ratio, climate, and topsoil to successful rehabilitation of the land and in recognizing the significance of special, natural, periodic phenomena, e.g. drought, but the goals of rehabilitation in the area are not stated in quantitative terms. The EIS should assess the consequences of rehabilitation failures and supporting evidence should be given for the projected 70-80 per-cent successful rehabilitation figure (I-79, 504-507).

b. Analysis of Accumulated Regional Impacts

Impacts of the proposed developments on the vegetation are considered, but the statements are not always backed up by references, and data are lacking in many cases. For example, in Table 10, this comment is relevant to both the vegetation section and to other sections as well (I-505). The vegetation figures in Table 10 are both appropriate and impressive, but a final decision on the importance of the impact cannot be made until the figures for each vegetation type are also expressed as a percentage of the total area occupied by each type in the Eastern Powder River Basin for which the EIS is prepared and also as a percentage of the total area in the Basin.

The EIS states: "...this habitat disturbance will most likely have a long-term cumulative impact on fish and wildlife populations and could result in losses which cannot be presently

quantified" (I-525). Such a conclusion should be further evaluated.

The section on the environmental effects of stack emission is incomplete. Statements such as, "Industrialization and development of the study area will result in a decline in ambient air quality," and "Effect of emission on vegetation and animals is not well understood at this time..." (I-466, 467) are indicative of incomplete data.

There is an inadequate discussion of toxicity hazards caused by soil disruption. Analysis of toxic trace elements, in addition to boron, present in the overburden spoils and the biotic impact anticipated with exposure to these spoils should be conducted. The comment, "Dust-covered vegetation...possibly toxic to livestock and wildlife" (I-507) must be analysed. Toxicants that will be released to air, water, and soil, given their respective susceptibilities to bioamplification in terrestrial ecosystems, could have profound and irreversible effects on agriculture and animal and human health.

c. Probable Adverse Impacts

1. There is insufficient analysis of the consequences of increased unavoidable stack emissions, e.g. potential doubling of sulfur dioxide, nitrogen oxides, carbon dioxide, between 1980 and 1990. No mention is made of selenium, mercury, or other toxic trace element releases (I-647, 655).

2. There is no support for the statement that vegetation destruction on 14,000 strip-mined acres will be temporary (I-655).

3. The projected five per-cent rehabilitation failure is

inconsistent with predicted 20-30 per-cent unsuccessful rehabilitation noted on page I-79.

d. Summary of Vegetation Impact

Analysis of regional impact is essential, but perspective on national impact is also badly needed since much of Wyoming's coal will be shipped elsewhere for burning.

The EIS should refer to sources of information in the text, and such statements as "serious impacts on health," "...certain qualitative impacts can be predicted," and "overall water quality may decrease," should be explained and referenced.

The direct adverse impacts of mining on vegetation are obvious, but secondary impacts of other activities may include vegetation damage as well. More information is needed to properly evaluate impacts, with special attention paid to the secondary, indirect impacts.

3. Wildlife and Fish

a. Existing Environment

1. Wildlife

Information on big game is more complete than any other section under wildlife, but two important items of information are lacking: 1) Deer and antelope population figures are presented only for the winter 73-74 (Table 28, I-323). Since ungulate populations can fluctuate significantly in density from year to year, estimates should be presented for several years prior to development. 2) No information is presented on elk migration routes. No population estimates were available for any predators or furbearers. Data based on limited sampling are present for rabbit, hare, and rodent population densities,

but these estimates were based on short-term sampling in only three small areas of the region.

Of the six game bird species in the region, population estimates were available only for one -- the sage grouse. No population estimates were presented for waterfowl, shorebirds or raptors. Estimates of songbird densities were provided from only one short-term study in only one location. This limited sampling cannot be considered to represent accurately the songbird community of the region. No population or distributional data were presented for any species listed as rare or endangered. Quantitative and even qualitative data, such as species lists, are completely lacking for all invertebrates.

2. Aquatic/Fish

There are no references for the "List of Known and Probable Fish Species Found in the Study Area" (Table 32, Appendix C), nor for the "various technical reports" (I-339) used in part as the basis for the descriptions of drainages in general and of the "selected individual habitats." Also, there is no methodological information.

Many statements are inconsistent. For example, smallmouth bass is listed as occurring in Keyhole Reservoir, but is not included in the "List of Known and Probable Fish Species Found in the Study Area" (Table 32, Appendix C); 14 of the 37 species of fish listed in Table 32, Appendix C, are not mentioned anywhere in the discussion; a nonexistent fish (the flathead minnow) is mentioned on page I-342; the flathead catfish, Pylodictus Olivaris, is not officially known to occur in Wyoming, and if it does occur it is rare; northern pike is not listed in

Table 32, Appendix C; the goldeye is mentioned on page I-346 as being on the U.S. Department of the Interior's "rare and endangered" list for Wyoming, but it is not indicated as "rare" in Table 32, Appendix C.

In addition, the description of the aquatic environment (fish and other) is inadequate. For example, there is no complete list of fish species occurring in any location. There are no data on aquatic invertebrates which occur in the basin, with the exception of two phyla and four orders mentioned (I-344). There are no data on aquatic plants and algae which occur in the basin, either in the section on "Vegetation" (I-268) or "Fish" (I-339). There is no information of the location of smaller ponds, streams, or reservoirs which may contain game fish, or which are mentioned as having been stocked. Finally, there is no physical description (e.g., surface area, volume) of water bodies.

3. Summary of Fish and Wildlife Impact

a. Important data specifics were omitted, such as time of sampling, specific sampling sites, and sampling methodology.

b. There are existing studies which should have been included in the EIS, including the grassland IBP data on short grass ecosystems. In addition, data on many of the areas deficient in the EIS is currently being gathered by a University of Wyoming research team.

c. A large number of statements in the EIS fail to cite sources.

d. There is no information on the population dynamics

of most of the animal species inhabiting the Powder River Basin, and, more importantly, there is no information on the interaction between any of the components.

b. Probable Cumulative Regional Impacts

1. Wildlife

There is a long and reasonable discussion of what the impact on wildlife might be as a function of destroyed and altered habitat, but there is a lack of specific information. With the information available it is impossible to assess the impact on the endangered species in the region, as was emphasized in the EIS:

> Inventories as to the exact occurrence and dependency of these species on the area to be developed and/or disturbed have not been accomplished. Therefore, precise impacts cannot be analyzed at this time...Without adequate knowldege of ranges and habitat requirements, a reduction in range may have serious long-term consequences. (I-529)

Until specific information is obtained on the success of revegetation of a variety of plant communities, no accurate estimation can be made of the short-term or long-term reduction in size of the big game herds.

Another impact which should be examined in greater detail is that of increased hunting, fishing, and camping. Assuming that hunters in the region will increase in proportion to the total population increase, there could be as many as 30,000 petential deer hunters in the region in 1990 (extrapolating Table 28, I-323). The deer population is estimated to be only 16,800. Adjacent areas will therefore be forced to absorb some of the hunting and fishing impact. Ultimately this means fewer licenses available per capita, smaller creel limits, increased management and supervision of game animals, stricter

enforcement of game laws and more maintenance for camping and recreation areas. Some estimation should also be made of additional personnel needed by the federal, state, and local agencies.

The EIS notes that "existing populations are diverse, numerous and important for their positions in food chains" (I-535). However, quantitative data should be presented on above-ground invertebrates, aquatic invertebrates and soil invertebrates. In mined areas soil organisms will be severely affected, and this could result in a long-term decrease in the rate of decomposition and, ultimately, nutrient cycling. Decreases in plant species diversity will result in a decrease in the insect species diversity. This simplified system could be more susceptible to environmental perturbations in the form of climatic changes, herbivores, parasites, and disease than undisturbed prairies.

2. Aquatic/Fish

There is no description of the amount of standing water (e.g., surface acres, number of ponds, miles of stream/river) which may be destroyed, or otherwise directly or indirectly affected by any of the projects. The EIS fails to fully examine the conclusion that the effect of off-site development "...cannot be overemphasized" (I-528).

The EIS is inadequate in terms of data describing the following effects: 1) alteration of stream flow or pond/lake volume via release or use of water; 2) amount and composition of petroleum products, detergents, solvents, sewage or other compounds which may be released into waters; 3) changes expected in dissolved ions; 4) amount and type of potentially toxic

elements and compounds reaching surface waters; 5) amount of suspended particulate matter reaching surface waters.

Furthermore, no data are presented on "tolerance," "acceptable levels," or any other measure of the ability of any aquatic animal or plant to withstand the effects of any of the variables.

The EIS suggests that new ponds and reservoirs may create new fisheries "...if water quality is adequate" (I-532). However, from the discussion of Water Resources (I-249), the quality of available waters and high evaporative rates make this doubtful in many cases. No indication is given concerning where most of the "ponds" would be located.

There is no discussion of the possible effects of stack emissions on the chemistry and biology of aquatic environments.

It is likely that a large storage reservoir will be constructed on the Powder River near Kaycee. This will clear up the river for some distance downstream. Clearing will also occur below any other reservoirs constructed on the Little Powder River, Little Missouri River, Belle Fourche River, or Cheyenne River. Most of the fish species (i.e., plains minnow, sturgeon chub, flathead chub, silvery minnow, goldeye, shovelnose sturgeon, river carp/sucker) of the above drainages are quite specialized species adapted to the very turbid waters of the upper Missouri River drainage. Clearing up these streams will eliminate the above-mentioned species, and the habitat will be taken over by the white sucker, creek chub, green sunfish, carp, and other non-game species. This has occurred in the North Platte River after reservoirs were constructed. Hence, there is a real possibility

of eliminating the rare sturgeon chub in addition to drastically altering the species composition of fish in the area.

The EIS states that "the extent and types of faunal effects cannot be determined at this time. The prediction would depend upon presently unavailable information, including location and size of projects" (I-528). Clearly, this information must be collected prior to the conduct of an adequate regional impact analysis.

3. Mitigating Measures

The EIS makes no mention of mitigating measures for wildlife and fish. Potential measures include the following: 1) stream diversions; 2) planning of road sites and fencing; 3) supplementary winter feeding for game animals; 4) mining plans which maximize recovery of topsoil; 5) establishment of grassland wilderness areas; 6) maintenance of stream and reservoir water quality; 7) no disturbance of critical watersheds or habitats.

4. Probable Effects Which Cannot Be Avoided

There are no estimates of losses of threatened species, upland game birds other than sage grouse, predators, furbearers, small mammals, songbirds, and shorebirds, important above-ground invertebrates such as pollinators, and important soil organisms such as saprophytic nematodes and arthropods and mycoorhyzal fungi.

There are also no estimates of the amount of aquatic habitat which will be destroyed or affected; the aquatic species (plant or animal) which will be killed or affected; the number of each species which will be killed or affected; and the way

in which water quality will be altered.

5. Short-Term Versus Long-Term Uses and Irreversible And Irretrievable Commitments

Every short-term adverse effect on wildlife could become a long-term effect, depending on the success of reclamation. However, there is no data presented in the EIS on the long-term success of reclamation.

The EIS does not evaluate the impact of getting additional water to the Powder River Basin. For example, it is noted that imported water would most likely come from the Green River, and that "...construction of a reservoir on the Green River would cause significant habitat (and productivity) loss in that part of the state." There was no discussion of, or data from, that part of the state anywhere in the regional analysis. Additional water may not necessarily come from the Green River. The Bighorn River has "extra" water, and it could be brought across from Boysen to the headwaters (dry) of the Powder River west of Casper and impounded in a reservoir in the Kaycee area. This possibility should be analyzed.

The analysis of specific projects in Volumes III and IV contains less specific information than the regional section. On-site information is almost completely lacking.

4. Conclusion - Fish and Wildlife

The following information is necessary to conduct a reasonable assessment of the development impact:

a. A complete description of on-site and off-site developments to be undertaken.

b. Data on the tolerance of organisms to perturba-

tions which will occur as a result of both on- and off-site development (e.g., changes in water chemistry, soil structure and composition; the presence of toxic elements or compounds and stack emissions; changes in recreational use of the area).

c. A detailed proposal for long-term monitoring of the mined and reclaimed area. Continuing studies of the biota should be conducted; for example, determining the extent and time it takes for biota to become re-established after disturbance. Such information would be invaluable in the future as a basis for environmental impact appraisals of other similar sites, and to evaluate the accuracy of predictions about the impact of development.

d. A plan for co-ordinating the various corporations, consulting firms, universities, and state and federal agencies which are conducting research and which have pertinent data.

F. Aesthetics And Recreation Resources

The discussions of aesthetics and recreation resources are reasonably accurate evaluations of the potential impacts that can be anticipated from large-scale industrial activity. Major flaws, however, are found in the discussion of primitive recreation resources, the lack of discussion of aesthetic and recreation resource impacts on a statewide level, and lack of proper source material identification.

1. Description Of Existing Environment

The concept and use of photo-interpretation in the aesthetics section of the Powder River Basin EIS is appropriate. There are good descriptions of major features of interest in the region (I-312-319). However, the report should mention

Thunder Basin National Grasslands as an important aesthetic feature.

The section on recreation resources has inaccuracies which should be corrected. For example, the map on page I-350 shows two state recreation regions but does not delineate their boundaries. In its discussion of Waterbase Recreation the EIS should include the Tongue River (I-359) as being under consideration for addition to the National Wild and Scenic Rivers System. The Laramie Mountains should be added to the Big Horns and Black Hills as an area which offers opportunities for cross-country skiing (I-360).

Under Primitive Lands, the EIS lists the Cloud Peak Primitive Area as containing 94,000 acres (I-362). This Primitive Area in fact includes 137,000 acres. In addition, the EIS should note that in November, 1973, in compliance with the Wilderness Act of 1964, the U.S. Forest Service proposed 150,490 acres to be re-classified as the Cloud Peak Wilderness Area. Considerable support for a 282,000-acre proposal was voiced at the same time. Congress will ultimately determine the final acreage of the Cloud Peak wilderness area.

Only one area is mentioned in the EIS as having potential as a future Primitive area -- the North Fork Powder River, including an area of 16,211 acres. In fact, the EIS should identify the following potential Primitive and Wilderness areas in this region:

1. Bureau of Land Management

a. Middle Fork Powder River. There has been support to make this a Primitive area (10,950 acres); however, the BLM

has proposed to manage this area as a "backcountry recreation area" in order to retain the natural condition of the area without formal designation.

b. Fortification Creek. This area has been identified by the BLM as a potential Primitive area of some 100,000 acres. A BLM report from the Casper District Office pointed out some of the interesting characteristics of this area: "This ecosystem is probably the only remaining area that closely resembles the ecology of the Powder River Basin prior to the influence of the white man...the area has value for comparability to assess ecological changes within the Powder River Basin, and as a reference point for anticipated mineral extraction activities."

2. U.S. Forest Service

a. Laramie Peak. An area of 10,420 acres was chosen for study as a Wilderness Candidate Area during the Roadless Area Review conducted by the U.S. Forest Service. Citizen groups have recommended an area of 26,800 acres.

b. Roadless Areas. There are numerous Roadless Areas in both the Big Horn and Medicine Bow National Forests which have provided and will continue to provide -- if properly managed -- quality primitive recreation opportunities:

1. Medicine Bow National Forest, Laramie Peak Division: Deer Creek, LaBonte Canyon, Buffalo Peak, and Eagle Peak

2. Big Horn National Forest: Cookstove Basin, Devil's Canyon-Porcupine, Pete's Hole-Sunlight, Cloud Peak Continuous, Hazelton, Doyle Creek-Taylor Creek, Grommand Creek, Rock Creek, Piney Creek, Little Goose, Twin Lake-Coney Lake,

Walker Prairie, Tongue River, and Little Big Horn.

c. National Grasslands. The Medicine Bow Forest staff is currently making an inventory of small parcels of land that could be protected as "natural areas."

2. Probable Cumulative Regional Impacts

It is evident that the aesthetic character of the land will be altered. The EIS sets the tone for the impact on aesthetics when it states "Because of the many new vertical intrusions on the skyline, Devil's Tower will no longer be one of the Basin's unique distant sights..." (I-516). This quote reflects the potential of coal development to degrade the unique scenic quality of our first National Monument and the surrounding countryside.

The section on recreation, for the most part, is well done and portrays accurately the fact that a large influx of people will serve to diminish the quality of the recreation resource. The recreation land base is particularly limited in the region, and any reduction in availability will increase pressures significantly on remaining areas. However, some references are unclear: for example, Projection Tables 12 and 13 (Hunting Demand [I-538], and Visitor Days [I-540]). The activity categories in Table 13 (Hiking, Picknicking, Camping, Fishing, Boating) are too general. Furthermore, the estimated percentage increases in recreational uses appear too low. Estimated "Backcountry" recreation demands in particular are far higher than other demands and should be analyzed as such. The ORRRC Report #3 shows considerable increases in this type of recreational use, projecting a "tenfold increase from

1959 (level) in wilderness recreation in the United States by the year 2000" (page 124), and projecting growth in total wilderness use in Wyoming by the year 2000 which would be "17 times the 1957 level" -- the highest growth figure for any region in the United States, and far higher than the national average (ORRRC Report #3, Wilderness and Recreation - A Report on Resources, Values, and Problems, page 237).

While the impact statement recognizes that quality recreation is subjectively perceived, it does not relate this generalization to Wyoming and the impact on quality from increased population pressures. The influx of great numbers of people into this region will decrease the opportunities for open-space recreation as well as increase crowding in developed facilities. Coal development means that all recreational activities will be affected by at least one factor -- more people on a finite recreation land base.

Increased population will also result in increased demand for urban/community recreation facilities by people who cannot or will not seek recreation outside their locales. This is especially true in Wyoming where climate encourages indoor activities during part of the year.

Finally, the section on recreation does not directly consider the state-wide impact on recreation resources. It alludes to it by stating: "Increased use of recreation resources outside the study area (Campbell-Converse counties) could result in the lowering of recreational quality in an ever-widening circle." (I-541). The statement fails to assess the impact which large numbers of people will have on Wyoming's traditional

open space values. The quality of hunting, fishing and other resource-based recreation activiteis will be degraded. Development of coal resources in Wyoming will increase in-state visitation and overall use of already-crowded National Parks where heavy traffic and overflowing campground and parking areas are already commonplace. Such development will eventually place additional "people pressures" on all of Wyoming's existing and potential wilderness
rivers.

The statement notes that in the peripheral areas of communities extensive recreation (open space recreation values) will be superceded by intensive recreation (in-town community facilities). As towns grow and engulf rural fringes, the character of the scenery will be altered, affecting both long-time residents and tourists. Once the neon signs arrive in Sundance, the beauty of the town and view of the countryside is diminished -- and the magnet for tourists lost. The intangible costs of these losses are not given due consideration in the EIS. Such long-term values are an important factor in the renewable resource base of this region.

3. Conclusion

Outdoor recreation is essentially a personal phenomenon which can be shared with close friends, family, a faithful dog, or one's inner self. Man seeks a relationship with nature -- whether a challenging motorbike ride on a desert road, a family picnic along a sandy beach, or an evening sojourn with a sunset surrounded by glaciers and high granite peaks. Such recreation is most satisfying when one senses a freedom of

existence and open space. It is not satisfying when it is structured or infringed upon by others. When outdoor recreation becomes crowded it becomes impersonal and artificial.

Wyoming has excellent outdoor recreation opportunities. The characteristics of open space, free skies, clear water, and magnificent scenery accentuate a quality hunt, a remembered fishing trip, a challenge successfully met. Perhaps the greatest single asset of outdoor recreation in Wyoming is ample space for all.

This impact statement should more thoroughly relate these particular values of outdoor recreation in Wyoming to the scope and potential impact of coal development in the Powder River Basin.

G. Agriculture

1. Description of the Existing Environment

The EIS states that "the number of acres under irrigated crop production has been rising gradually over the years but is limited by water" (I-375). Further, the statement notes "demand for irrigation water exceeds the supply" (I-379). Major new power company demands for water supply will therefore create additional difficulties for providing adequate water for food production. The EIS further describes large amounts of available water in the tertiary formation (I-257), but in the succeeding paragraph the statement notes that "the nearest and most logical sources of additional surface water supplies are from streams draining the Big Horn Mountains and Black Hills and from the Platte River System."

The statement is also made that "sheep numbers have been

on the decline in recent years. Numbers recorded were 303,700 head of sheep in 1974 for the two-county area" (I-371). Yet in Table 36, the total number of sheep in the two-county area, as of January, 1972, was only 243,400 (I-370). This would indicate that, in fact, sheep numbers are on the rise, thus requiring more forage and more water. Moreover, the statement: "sagebrush, by far the most common shrubby forage species, is utilized primarily by sheep" (I-371) is in error, since sagebrush is only utilized by sheep to any extent in the winter months. In fact, IBP Grassland Biome research has documented that wildlife are the primary utilizers of sagebrush.

The EIS also states that "an average of 2,480 acres of cropland are annually irrigated in Campbell County compared to 65,073 acres devoted to dryland farming"(I-378). Yet in Table 40 (I-376) the major irrigated crop average adds up to only just over 1000 acres and the major non-irrigated crop average adds up to over 75,117 acres.

No support is provided for the statements that "total dryland cropland has decreased over the years..." and "during the past two years, some of these lands have again been placed into crop production in response to recent changes of government farm programs and rises in grain prices" (I-375).

Such discrepancies between figures in table and in text occur frequently throughout the sections on Agriculture and cast doubt on the text's usefulness as a reliable base of information.

2. Probable Cumulative Regional Impacts

The EIS should include all power development proposals

in its regional analysis; for example the impacts of the ten electric generating plants proposed for the Powder River Basin five years ago in the North Central Power Study which are presumably still being planned.

Failure to take related energy developments into consideration will result in a minimization of environmental impacts and an inaccurate basis for decision-making.

The impact statement states that "secondary impacts (on agriculture) associated with population increases due to construction, mining, and related developments will occur" (I-543). However, no attempt is made to project what these losses might be in terms of lost Animal Unit Months (AUM's) or forage acreage. Mention is made of effects on livestock production as a result of construction of railroads and roads which alter established use patterns (I-543), but none of this material is projected into actual figures for summary purposes (see Table 14, I-544).

The EIS minimizes impact by stating "the direct loss of agricultural land and production by 1990 would not constitute an important regional impact, as lost production by that time is anticipated to represent one per-cent or less of the total regional agricultural production" (I-547). In the preceding paragraph, however, the EIS states that six per-cent loss of irrigation water would represent "the loss of a source of winter feed to the livestock industry equal to 67,200 tons of hay in an area with a winter feed deficit." The cost to the ranchers of replacing this hay for cattle and sheep would be a significant impact. However, no projected financial losses to the rancher are included. Additionally, in Table 15 (I-546), a figure of

31,473 acres of irrigated cropland is expected to be lost to industry through water rights conversion by 1990. If, as presented in Table 14, irrigated pasture provides 1.62 tons of hay per acre, it follows that, in fact, by 1990, 50,986 tons of hay will be lost each year.

The EIS further fails to identify the extent of the region being impacted or the extent of current agricultural production in the area of mining. Burlington Northern projects "a permanent loss of grazing on the 2,400 acres of right-of-way" and 550 acres outside the right-of-way (II-159); Atlantic Richfield indicates "grazing on the entire 6,524 acres of the mine area would be disrupted" (III-199); and Wyodak indicates that "mining will remove 2,080 acres of grazing land from production" (VI-89). There is no description of criteria used to consider an impact as a "regional impact."

The statement notes that "some loss of livestock water is anticipated through change of land use or land severance" (I-545) and reference is made to "increased vandalism of livestock watering facilities and drying up of livestock water sources" (I-662). The EIS also presents tables for the total of irrigated acreage in northeastern Wyoming, principal reservoirs in northeastern Wyoming, estimated depletions of streamflow, and numbers of adjudicated acres. However, nowhere does it present figures in acre feet showing the relation between loss of irrigation water to industry and amount of irrigation water available for agriculture. Yet it is repeatedly

stated that "loss of water for irrigation could not readily be replaced from existing sources and irrigation water is inadequate to supply current needs (I-547).

According to the EIS, "Wyoming statutes provide for a change of water right to higher, preferred uses, with industry use rated higher than agriculture. Requests have already been filed with the State Engineer for changes in water use from agriculture to industrial use totaling approximately 1.5 million acre feet" (I-539). However, previously the EIS stated that requests for additional industrial water use totalled 1 million acre feet of water (I-501).

According to the EIS, "based on the assumption that the best technology will be applied, an estimated 70 to 80 per-cent of the mined land surface would be expected to be successfully rehabilitated under existing climatic and soil conditions" (I-79). Yet subsequently the EIS states:"the return of agricultural land to production after reclamation depends on rehabilitation success. To determine unavoidable losses, a five per-cent rehabilitation failure and 10 per-cent conversion to other uses was assumed," (I-662). The reclamation percentages cited in the two sentences quoted here should be justified, or the difference between them reconciled.

The problem of erosion which is an integral part of the mining operation, is not sufficiently addressed. Reference is made to the effect of increased erosion and sedimentation due to mining operations, but no definite acreages are mentiond (I-545). The only mention of erosion control refers to the Wyodak operation, stating that "when feasible, erosion control and flood control structures would be built prior to starting

excavation" (VI-109). The EIS should make erosion control a precondition for granting coal leases.

3. Mitigating Measures

There is no section on regional mitigation measures for agriculture, although the EIS states that agriculture is one of the most likely components to be affected (I-459). Considering the probable severe impact on agriculture due to the mining operations and water righr conversion, mitigating measures should be discussed on a regional basis.

Mitigating measures are covered to some extent under separate coal company proposals. The proposed measures seem reasonable, but no attention is paid to the necessity of water for reclamation, nor is reference made to finding new sources of water to maintain the level of agriculture.

Steps that might be taken to minimize the effect on agriculture include: a) measures to return water rights to the state for agricultural use after termination of the industrial operation; b) encouraging industry to explore for deep underground water (which is present in great abundance in the tertiary formation underlying the Powder River Basin); c) a state mandate that agricultural water must stay with the land, and a provision that companies lease back to the landowner the land and water until such time as it is needed by the company, or farm the land itself. This will insure that the least amount of agricultural land is taken out of production.

4. Probable Adverse Environmental Effects Which Cannot Be Avoided

The perspective taken by the EIS on the rate and

scale of development, considering the lack of discussion on mitigating measures, resulted in conclusions that a great deal is "unavoidable."

Another defect is the conflicting figures presented on hay loss and AUM's. There are at least three different figures presented for annual hay loss due to loss of irrigation water for the period 1975-1990: 12,235; 50,986; and 67,200 tons. The highest figure is based on a loss of 13,200 acre feet through water right conversion to industry (I-547). However, the projected unavoidable losses of AUM's (I-662) are based on the lowest figure of 12,235 tons (549 tons annually as found on Table 14, I-544).

The conflicting figures for water rights on file with the State Engineer also affect the projected hay loss and the loss in AUM's. Such conflicting figures can compound subsequent discrepancies and thus greatly affect the final evaluation of unavoidable adverse impacts.

H. Land Use Controls

Extensive change in land tenure and patterns of land use will be one of the major impacts of Powder River Basin coal development. Land use planning and other efforts designed to mitigate these changes are therefore of extreme importance.

1. Description of Existing Environment

Aside from a very brief discussion of land tenure, the Regional Analysis presents no comprehensive description of present land use patterns. In the portions of the EIS dealing with railroads and mines, there is no discussion of land use planning as it relates to specific developments.

Although most land use agencies have sufficient authority to impose effective land use controls (I-391), the level of commitment to do so varies a great deal. Only one of the counties in the region (Campbell County) is moving toward development of a county master plan (I-390). Although the EIS does state that nearly all of the cities have master plans and zoning ordinances (I-390), there is no discussion of the adequacy of these plans to deal with the problems imposed by new development.

2. Accumulated Regional Impacts

As only one of the counties has proceeded to develop a master plan, the impact of the developments on less well-prepared county governments must be evaluated. Another major omission is the lack of any discussion on available financing for land use planning and control efforts.

3. Mitigating Measures

The mitigative measures section of the EIS proposes no specific techniques which communities in this region can use to deal with impending development; for example, subdivision regulations. Nor is there any discussion of measures that can be taken by the State to control the pace and direction of the development (e.g., Energy Conversion Facility Siting laws).

Although 60,000-100,000 acres in two counties have passed from private to corporate interest (I-553), there is no discussion of the effect this will have on the local economy nor of how to control this change.

4. Adverse Environmental Impacts

Adverse environmental impacts that would result directly from changes in land use patterns are not discussed in the EIS.

I. Socio-Economic Analysis

1. Description of Existing Environment

Despite the fact that a large amount of data on socio-economic conditions is presented in the EIS, there are several major omissions.

First, the statement fluctuates between a regional description and site-specific descriptions. An adequate regional description should include a wide array of socio-economic facts, especially financial information, on the major sectors of the regional economy (e.g., tourism, agriculture, and industry). Consideration should have been given to the consequences of shifting from a predominantly agricultural economy to an industrial economy. The possibility of "boom and bust" development of coal should have been analysed. Short-term and long-term behavior of the regional economy should have been projected since it is almost certain that the coal development will diminsh in the relatively short run -- 40 to 50 years.

There are numerous errors in the data presented, such as estimates for houses in Campbell County which fluctuate between 3,937 and 12,665 (I-407). Also, a number of socio-economic studies, such as the Northern Great Plains Resources Program Studies, are available. These should have been utilized in the statement.

The most serious omission in the EIS is exclusion of any

cost-benefit figures for the changes in social service needs caused by the proposed activities.

Table 5, attached hereto, is a summary of the employment figures contained in Map 6, Appendix A. The EIS fails to clearly indicate how total population figures were derived from the basic employment figures contained in Map 6. The only explanation presented is as follows:

> Impact on other residentiaries is a direct function of population and employment in the basic sectors (only construction and other residentiaries are considered nonbasic or secondary). Although a precise numerical relationship does not exist between employment in the basic sector plus construction and employment in other residentiaries, a range can be made. On a regional basis (Table 45, Appendix C) for the years 1970 through 1990, the ratio of basic plus construction employment to total employment ranges from 0.35 to 0.37. Thus, one additional employee in a basic sector (coal, etc.) induces a total employment of 2.7 to 2.9 persons, the difference being attributable to other residentiaries. The figures are not as important as realizing for each employee in coal mining, coal gasification and power generation, more than two employee positions are induced in other residentiaries (I-566).

The EIS also fails to describe how construction workers were treated in making the calculations. The second quoted sentence groups the basic sector alone and construction and residentiary together. The third sentence groups the basis sector and construction in comparison to total employment. In any case, no calculations using the ratios indicated in the quoted paragraph yield the population figures used in the EIS.

If an employment multiplier of 2.8 were used to calculate total employment, and a population multiplier of 3.2 were applied to the figures in the table, the new population in Campbell County would be 98,067 by 1980. Total population would equal 110,664 in Campbell County by 1980. The statement gives the figure 32,200 (I-556).

Table 5

	Permanent	Construction
Campbell County *		
Atlantic Richfield Co.	400	200
Carter Oil	1000	2700
Kerr-McGee	225	200
Wyodak	190	1480
Belle Ayre South Mine	250	100
Rochelle Mine	225	250
Rochelle Gasification Plant	800	2500
Belle Ayre North Mine	325	100
Subtotal	3,415	7,530
Converse County		
P.P. & L. Mine	200	150
Total	3,615	7,680

* No employment figures are included in the table for the proposed railroad because there were no figures for the railroad on Map 6.

The following table calculates the population for the described developments as recommended by the latest Department of Economic Planning and Development report, Coal and Uranium Development of the Powder River Basin - An Impact Analysis. The DEPAD method has a tendency to estimate low (see pp 51-59 of the report).

Table 6

Population Estimate for Campbell County
1980

	Employment	Population
Permanent Employees	3,415[1]	8,537.5[3]
Construction Employees	7,530[1]	15,060.0[4]
Induced Service Sector Employees	7,005[2]	17,512.5[5]
TOTAL NEW POPULATION		41,110.00

[1] Given - from Table 5 above

[2] Induced Service Employment = permanent employment x permanent service multiplier + construction workers x construction service multiplier (3,415 x 1.50 + 7,530 x .25 = 7,005)

[3] 8,537.5 = permanent employment (3,415) x permanent population multiplier (2.5)

[4] 15,060 = Construction employment (7,530) x construction population multiplier (2.0)

[5] Service workers are treated the same as permanent employees since they will establish permanen residences (17,512.5 = 7,005 x 2.5)

When the new population estimate (41,110) is added to the present population (12,597), the total population for Campbell County for 1980 is realistically estimated to be 53,707, as opposed to the statement's projection of 32,200, and the EIS should re-evaluate the estimate.

Even a 50,000 + population figure may be a low estimate for Gillette by 1980 if persistent reports of additional coal-related developments not included in the EIS are considered. Moreover, the basic figures were furnished by the companies themselves and may be conservative. For example, ARCO estimates 400 permanent workers to mine 10 million tons annually, while Kerr-McGee estimates only 225 permanent employees to mine 16 million tons annually.

Since the impact in all of the socio-economic areas discussed in the EIS is dependent on the accuracy of the population projections reviewed above, this section should be entirely re-calculated and re-evaluated.

Even accepting the projections of the EIS, however, there are serious errors or omissions in the descriptions of many of the socio-economic impacts. Because 90+% of the described impact occurs in Campbell County, the following analysis is limited to that county.

Health and social service analysis is misleading. For example, the EIS states "with 13 acute beds and 125 extended care beds, Campbell County is in a good position to provide an acceptable level of service to its present population" (I-433). In fact, Campbell County has a serious medical service problem.

In 1974 Campbell County had five physicians. But members of the hospital board and the hospital administration staff indicate they actually have only the equivalent of 2-1/2 functioning doctors, since three of the five have physical ailments which limit the work load they can carry. Also, the average age of the physicians is over 55, with two of the five being over 60. Several of the five would like to slow down and partially retire. Thus the problem of physician shortage is much more acute than the EIS indicates.

According to Table 62, Campbell County will need 45 to 50 new acute hospital beds by 1980. The county will need most of these new beds by 1978, which is when population will peak in the county for the five-year period. Therefore, the bed shortage for Campbell County will become serious within three years. To lump together estimates for all hospital facilities for the eight counties when most of the population will live in one county is a serious error. Utilization rate of the Campbell County hospital is artificially low because upwards of 30 per-cent of Campbell County residents go to Casper, Buffalo, or Sheridan because of the shortage of physicians.

The Northeastern Mental Health Center in Campbell County is also likely to have trouble continuing to provide the current level of services. A federal grant provides approximately one-third of its budget and this funding expires in 1975. A population increase of 40,000+ would necessitate approximately ten new staff members just to continue the present level of services. Even if the county could provide the salaries for

that many new staff members, it would be hard to recruit trained, qualified individuals.

The EIS does note that the Division of Public Assistance and Social Services will suffer a load increase. The statement points out that "...although the public assistance function will not be seriously affected by rapid mineral-related development, certain isolated impacts may occur"

The public assistance function did increase sharply during the oil boom. A mineral boom will continue to attract people to the area even after the job surplus has disappeared. Often these people will require public assistance in order to move or to hold out until jobs again open up. Given the number of new jobs being proposed, the budget for public assistance may have to be greatly increased. The EIS should evaluate this potential impact.

The EIS states:

> The practical consequences of rapid development have seriously affected the residents of this area. A shortage of vital public services, including water, sanitation facilities, housing, schools, medical services, and recreational outlets, has strained both public officials and citizens alike. This stress has been reflected in the increasing incidence of family discord, adjustment problems, truancy, and alcoholism. (I-455).

Yet most of the description of the section on health and social services claims there are few, if any, shortages in these public services. A survey of attitudes toward public services, on the other hand, was summarized as follows for Campbell County:

> Attitudes toward five public services (medical, schools, recreation, police and postal services) showed respondents were somewhat dissatisfied. On a five point scale running from one for high degree of satisfaction, three being neutral, to five for high degree of dissatisfaction, the following scores were recorded: medical services, median = 3.959; schools, median - 2.126; recreation, median - 2.939; police-sheriff; median = 2.432; and postal services, median - 2.154. Respondents were satisfied with schools, the postal service and police sheriff; neutral on recreation; and dissatisfied with medical services. Only six percent were very satisfied while 31 percent were very dissatisfied with medical services. With regard to school service, 19.6 percent were very satisfied while only 3.8 percent were very dissatisfied. Efforts should be expended to improve medical services in Gillette and Campbell County." (Survey conducted by the Dept. of Sociology, University of Wyoming.)

Tax revenues from mobile housing should be contrasted with revenues from conventional housing and differences noted and planned for. More information on mobile home construction standards, location of parks, and service problems should be included.

Cost and revenue figures need to be calculated for demand for additional public education. The number of new classrooms, teachers' salaries, and other associated costs should be calculated. These costs should then be contrasted with additional revenues which the school districts will receive from the proposed activities.

Cost and revenue figures for law enforcement should be provided. Staff at Campbell County Sheriff's office have indicated they are already having trouble keeping employees because they cannot match the salaries of the energy companies.

The analysis of water and sewer system capabilities in Gillette is reasonable, but cost and revenue figures are necessary

to give an idea of the extent of impact. Both the water and sewage system will have to expanded by 1985. The critical questions are whether sufficient revenue will be developed by the proposed developments, and if so, when it will be available. The EIS should also include an analysis of water and sewage problems for Campbell County as a whole.

Two large mobile home parks have been publicly announced for construction at Reno Junction, and there will probably be more such developments requiring both water and sewage treatment. Information on sanitary problems, water supply, subdivision regulations, etc., regarding mobile homes needs to be included in the statement.

2. Mitigating Measures.

The EIS completely omits discussion of mitigating measures for socio-economic impacts, although a number of activites could be undertaken to help mitigate these consequences.

Impacted communities will need additional revenue to prepare for population increases. Possible sources of revenue should be identified and obstacles to increasing revenue removed, particularly if they require legislative action.

State government could force development companies to divulge their plans ahead of time. This would enable communities to prepare for development. A means of recourse for localities could be devised if company estimates prove to be wrong.

There should be some means for slowing down the rate of development in a particular area. Campbell County, for example, will receive the lion's share of the burden of providing public services for the activities proposed in this EIS and will

receive the majority of that burden in a very condensed time period -- three to five years.

3. Probable Adverse Environmental Effects

The purpose of this section of an EIS is to identify what adverse effects can be avoided and how, and then to identify what effects cannot be avoided and estimate to what extent they will occur, thus giving decision-makers an idea of the socio-economic costs. Officials can then decide if the benefits of the proposed development justify the unavoidable costs.

The Powder River EIS concludes that the quality of almost every public service in the heavily impacted communities will seriously deteriorate. This conclusion of unavoidability, however, is incorrect. Most of the adverse environmental effects could be avoided or at least mitigated if full responsibility is exercised by appropriate decision-makers.

The most significant factor is time. Given the hastened development schedule proposed by this EIS, no amount of effort can prevent serious community deterioration in at least two communities. But if corporate and government decision-makers slow down the rate of development, the adverse impacts will be reduced.

The second factor is money. Given some relief in the time schedule and sufficient start-up money, communities could prepare so that adverse impact could be minimized.

In fact, with good planning, there is the strong possibility that the communities could be improved. But improvement will require very explicit decisions regarding these two major factors for desirable effects to occur. If these two factors

are ignored, several communities in the Powder River Basin could be seriously damaged. Once public services start to deteriorate, the process compounds, affecting other areas. For example, if additional doctors are not recruited before 1978, the pressure on those doctors in the area will increase, perhaps influencing them to retire or move elsewhere. The same is true of staff in all the public service areas; their skilled services are in high demand in other parts of the country, and if the conditions of their employment become intolerable, they may leave.

The EIS should outline the range of possible social impacts and relate them to the coordinates of time and money. If the different possibilities for social impact are made explicit, they can serve as a guide for policy-making. All such impacts are avoidable to a degree; specifying this degree is the task the EIS should have performed.

4. Conclusions

The most serious deficiency in the socio-economic sections is the lack of financial information. Regional analysis of the economic sectors is almost nonexistent. In particular, analysis of the long-term impact of the decline of the agricultural sector should be developed.

Population estimates need to be refined. All employment figures, including all development, should be arranged in one table. The estimation procedures should be clearly spelled out so the accuracy of the calculations can be verified.

The sections on Health and Social Services are inaccurate and incomplete. More specific information should be collected, particularly for Campbell and Converse Counties. The sections

on housing should include more specific information related to mobile homes as described above.

V. Alternatives

A. Alternatives to Proposed Development

This section offers some alternatives to the proposed development in the Eastern Powder River Basin, e.g., "A Delay Pending New Technology," "In Phase and Staged with Socio-economic Development," and "Control Location of Depletion by Designating the Area for Production," which includes protecting areas of unique resource value other than coal. However, this list of possible alternatives raises additional issues which should be analyzed and referenced. These include the following:

1. The potential adverse impact on water resources, open space, and human resources resulting from gasification plants;

2. The industrial and socio-economic impact resulting from mining of thin coal beds;

3. The government assumption of commitments made by private industry prior to their obtaining clearance to proceed with mining (I-672).

B. Alternative Extraction Methods

The EIS fails to recognize that surface mining has effects on hydrology and dust problems of at least equal, if not greater, magnitude than underground mining. In addition, the impact of drilling and blasting was not discussed in the surface mining alternative (I-682).

C. Alternative Reclamation Objectives

1. The EIS notes that "a less diversified vegetation, possibly a monoculture suitable for livestock forage, would be established. This would limit wildlife diversity and would be less attractive for recreational purposes" (I-688). Other problems associated with a monoculture should be articulated in the EIS, i.e., drought, pests, and disease.

2. In the wildlife section no mention is made of fish and aquatic habitats.

3. The section on recreation lists undesirable impacts from increased recreation (litter, erosion, noise, and dust from ORV's) and yet states that, "this alternative could provide sorely needed opportunities in the event population growth becomes significant in the area" (I-690). This conflict should be fully analyzed.

4. Multiple use is described as "optimization of the various uses in harmony with land capability" (I-692). However, the EIS does not consider restrictions of development on a "multiple use" basis.

D. Alternative Mode of Distributions

1. The alternative "to return the water via a separate pipeline to the basin for reuse" is not fully evaluated.

2. The 19 transmission lines required would be a visual distraction as well as occupying 16,400 acres of right-of-way, and the alternative of underground lines is not considered.

E. Alternative Sources of Energy

Alternatives are merely examined "to the extent present technological development permits."

1. Table 3 does not list the potential yields of solar, wind, and geothermal energy (I-709)

2. The section on production from Outer Continental Shelf sources emphasizes delay but fails to compare the delay associated with coal production.

3. The EIS states that by 1985, through leasing on the Outer Continental Shelf, "1.5 billion barrels of oil will be produced, which is approximately 16 per-cent of total projected national energy requirements" (I-710). This statement, however, is not related to coal development in Wyoming.

4. The discussion of nuclear stimulation for natural gas (I-766) fails to recognize that Project Rulison (near Rifle, Colorado) did not clearly demonstrate that recovery of natural gas by nuclear explosion is technically feasible and economically promising. In fact, the gas became contaminated and the project was abandoned.

5. The description of western coal should include an analysis of the value of western coal compared to the value of eastern coal and relative sulfur content. A measurement of 0.7 per-cent sulfur is listed for bituminous coal as the requirement to meet the emission standards for sulfur dioxide of 1.2 pounds per million Btu's of fuel burned. However, the average per-cent sulfur for subbituminous western coal to meet the standards is unclear. On the basis of Btu content, eastern coal reserves of low sulfur coal far outweigh western reserves. It takes half again as much western coal on a tonnage basis to equal the Btu's of eastern coals; this increases the amount of sulfur released per million Btu's generated. Most western coals would

place in the medium sulfur category when measured by emission per million Btu's generated.

6. In the discussion on nuclear power there is an assessment of risk conditions. However, there are no comments about the risks related to sabotage plants, and theft of nuclear materials (in transit) to build nuclear devices.

7. The EIS fails to clearly identify the technical and economic constraints on geothermal energy development.

F. Other Energy Sources

The EIS dismisses "exotic" resources as follows:

> Other energy sources that might in the future be alternatives to coal are not presently considered viable because production technology is not developed, and time for development would be measured in several years or tens of years... No appreciable energy can be obtained from these systems within a relevant time frame. (I-843)

1. Wind Energy

More data and references should be provided for the estimates of the ultimate energy potential of wind energy. The EIS merely notes: "Wind forces vary unpredictably at many locations thus requiring large energy storage facilities for any sustained use of wind energy for power." (I-848)

However, many experts believe that wind power is a viable alternative. A committee appointed by the National Science Foundation and the National Aeronautic and Space Administration

has suggested that by the year 2000, a major American development in wind power could result in an annual yield of 1.5 trillion Kilowatt-hours of electricity. That is equal to the total electricity consumed in the United States in 1970. In "Return of the Windmill," (Smithsonian Magazine, November, 1973) it was stated, "NASA officials believe that with mass production, electricity generated by wind power will be available at capital costs which a decade from now will be competitive with nuclear power plants."

2. Solar Energy

Solar energy is also a potential viable energy resource which should be more fully evaluated. The EIS merely states:

> The requirement for large collector areas and the low efficiencies make it unlikely that solar energy will become an important source of power within this century. Even a 300 percent increase in solar cell efficiency would not result in economically acceptable power costs for general use. (I-850)

3. Recycling Organic Wastes

The impact statement notes "Organic wastes in the U.S. are potentially a source of appreciable energy" (I-851). However, the EIS fails to adequately examine the results of current experiences in a number of U.S. cities where organic wastes are being used as a fuel source for power plants.

G. Conclusion - Alternatives

The conclusions of this EIS underline the inherent bias towards traditional coal extraction by saying: "In view of the trends and problems discussed above, it seems reasonable to postulate that for some time to come the best alternative to

the production of the coal from the Eastern Powder River (Coal) Basin of Wyoming would be to produce an equivalent amount of similar coal from elsewhere in Montana, Wyoming or North Dakota" (emphasis added) (I-857).

VI. Summary of The Major Conclusions of the Disciplinary Critique

A. Climatology and Air Quality.

1. The EIS does not recognize that atmospheric observations conducted in the Powder River Basin suggest that there will be one pollution episode lasting at least six months each year.

2. Extremes of precipitation in the Powder River Basin are not properly emphasized in the EIS. In about five out of ten years, the Powder River Basin receives less than ten inches of total precipitation.

3. An amendment to the Wyoming Air Quality regulations is needed to require that not only the amount of allowable particulate matter from stack emissions be delineated, but also that the composition of the emissions be identified.

B. Soils

1. The EIS fails to assess potential losses in land productivity. The destruction of the soil nutrient storage balance eventually results in very sterile soil conditions.

2. The statement also inadequately addresses the handling of soils which will be directly impacted by mining.

C. Geochemistry: Mineral and Trace Elements

1. The overburden will contain toxic materials. There are possible problems with concentrations of boron, molybdenum, beryllium, cadium, and selenium.

2. The effect of the proposed mines could be an increase in salinity of surface water to a level which would make the water unsuitable for livestock and wildlife use.

3. The EIS should address the problem of acid rain resulting from sulfur dioxide (SO_2) release from generating plants and gasification plants.

D. Water Resources

1. The EIS is critically lacking in data on water use.

2. The EIS states that there is a recharge rate of 150,000 acre feet of ground water annually, but the latest Wyoming Water Plan shows 100,000 acre feet or less. The relation between recharge rate and changes in the surface drainage system must be fully analyzed.

E. Biota

1. The EIS seriously lacks the following: a) vegetation productivity data; b) population estimates for species vertebrate species; c) quantitative and qualitative data on invertebrates. tebrates; d) qualitative and quantitative data on soil organisms; and f) population estimates and distributions of threatened species.

2. The population data which are presented are only for one season and/or one sampling time.

3. The tolerances and resource requirements and extent of the interactions between even the major species are unknown and should be analyzed.

F. Aesthetics and Recreation Resources

1. The EIS accurately evaluates potential impacts

that will come with large-scale industrial activity. The most important impact is the gradual loss of large open spaces as a specific resource. Too many people on a finite land base will close the open spaces and significantly degrade the quality of outdoor recreation experience.

G. Agriculture

1. Discrepancies between numbers presented in tables and numbers presented in the body of the text occur frequently throughout the sections on Agriculture.

2. In the section on "Probable Cumulative Impacts," no attempt is made to project impacts in actual numbers, the units of which are comparable in all cases. Hence, it is difficult, if not impossible, to assess the regional effects of development.

3. Mitigating measures are not discussed on a regional basis. Mitigating measures are discussed to some extent under separate coal company proposals. However, even these analyses do not recognize the necessity of water for reclamation purposes.

4. The discussion of reclamation ("Resource Disturbance") puts little emphasis on the ultimate use of the land in an agricultural framework. It also utilizes a very narrow information base compared to that readily available in the published literature.

5. Many effects of development which may have a detrimental effect on agriculture are not discussed in detail (e.g., location, mileage, and type of roads, the effect of separating agricultural lands from water sources, and disruption

of established patterns of use.)

H. Land Use Controls and Constraints

1. There is no comprehensive description of land use patterns in the EIS, and the discussion of regional impacts is also, therefore, inadequate.

I. Socio-Economic Analysis

1. The EIS does not include an economic analysis. Cost benefit analysis should be done on both a regional basis for sectors of the economy and at the community level for public services.

2. The population estimates are incorrect and understated.

3. Information on Health and Social Services is superficial and inaccurate.

VII. Recommendations

As stated in the introduction, the Reviewers believe that the EIS should be rewritten, additional public hearings held, and a moratorium declared on implementation of this proposal pending development and analysis of considerable additional information.

Draft revision and new public hearings are especially important to individuals and groups in Wyoming where the impacts will occur and the majority of costs will be borne. Public hearings are the most direct opportunity to influence agency decisions. A revised draft, which at a minimum should cover the factors enumerated in this review, will provide the essential basis to permit objective analysis and effective input into the decision-making process.

The review team has concluded that information from the Northern Great Plains Resources Program has not received sufficient recognition in the five-volume EIS. Members of the review team have participated in NGPRP and reviewed several of the draft reports. There is considerable information in this study that bears directly on the regional analysis, impacts, mitigation, and alternatives described in the EIS.

In light of the strip-mine legislation which recently passed in the House and Senate, there should be a total revision of the impact statement assumptions for controls, planning, and mitigation. The involved agencies should conduct research on mitigation measures which can be written into mining plans and other administrative decisions.

The review team has further concluded that it would not be in the public interest to approve any development in the central part of the Powder River Basin between Gillette and Douglas at this time. The EIS itself has pointed up many substantial information gaps, stating numerous times that environmental impacts of various developments cannot be predicted. Therefore, coal development decisions of such magnitude should not be made until a substantial amount of critical, additional information has been developed and evaluated.

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